DOCUMENT RESUME

ED 133 162 SE 021 477

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TITLE Energy Futures... [Project ECOLogy ELE Pak, Parr Pak].
INSTITUTION Highline Public Schools, Seattle, Wash.
SPONS AGENCY Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
PUB DATE [76]
NOTE 58p.; For related documents, see SE 021 438-478; Contains occasional light type
AVAILABLE FROM Highline Public Schools, Instructional Division, Project ECOLogy ESEA Title III, Bill Guise, Director, 15675 Ambaum Blvd., S.W., Seattle, WA 98166 ($2.50)

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS Conservation Education; *Energy; Environment; *Environmental Education; *Instructional Materials; Junior High School Students; *Natural Resources; *Secondary School Science; *Units of Study (Subject Fields)
IDENTIFIERS Elementary Secondary Education Act Title III; ESEA Title III

ABSTRACT

This is one of a series of units for environmental education developed by the Highline Public Schools. This unit on energy is designed for junior high school science students. The 11 concepts of the unit have been developed into 11 lessons that should take from two to three weeks to complete. Each lesson includes the concept of the lesson, materials needed, notes to the teacher, procedure, evaluative activities, and suggested additional activities. (RH)

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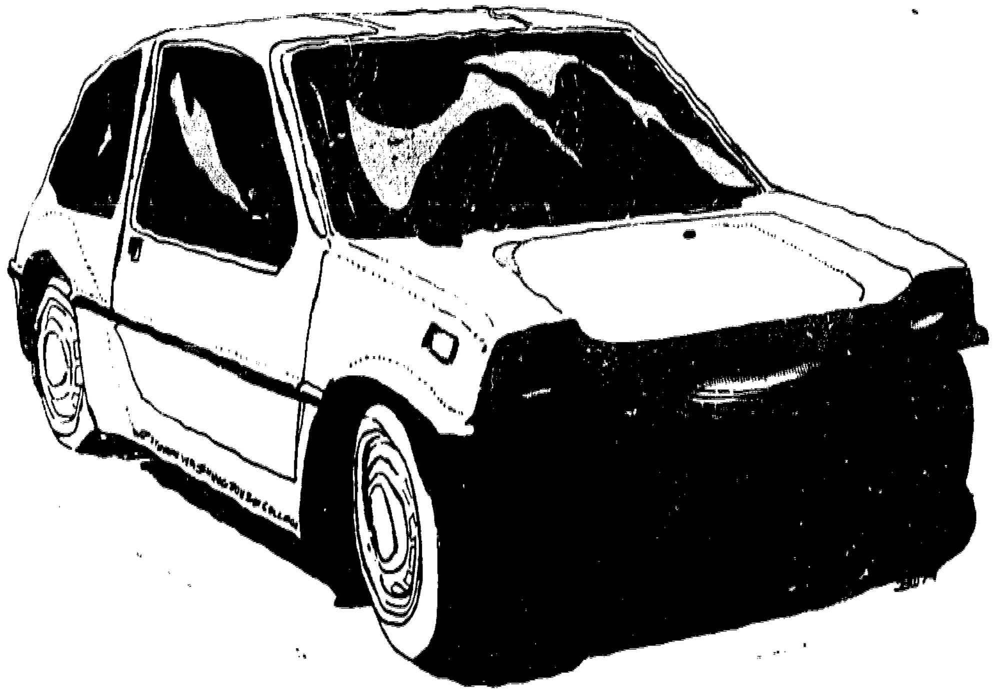
ENERGY FUTURES....



By Donald Parr

An Environmental Learning Experience for Junior High Science. One of many "ELE Paks" available for all areas.

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NATURE KNOWS BEST

PROJECT ECOLOGY TITLE III

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Evaluation Results Regarding This ELE May Be Obtained by Including This Page and a Self Addressed Stamped Envelope To

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EVERYTHING IS CONNECTED TO EVERYTHING ELSE PROJECT ECOLOGY

THERE IS NO SUCH THING AS A FREE LUNCH PROJECT ECOLOGY TITLE III

EVERYTHING MUST GO SOMEWHERE • TITLE III PROJECT ECOLOGY

CONCEPTUAL OVERVIEW

1. The development of energy takes many forms.
2. How much energy does the student and his family use?
3. How much energy does the school and community use?
4. Energy use in the United States.
5. Renewable energy sources.
6. Non-renewable energy sources.
7. The conversion of energy.
8. Energy conversion in electricity generation.
9. The need for additional electricity.
10. Conservation of energy.
11. Energy sources in the future.

RATIONALE

The energy crisis is here now. It is a problem that both the present and future generations will have to solve. It is not the figment of imagination. It is reality. Our current gasoline shortage is just the beginning. We are running out of the energy sources we use the most, fossil fuels. Scientists are desparately searching for long range solutions to the problem.

The student of today will be directly involved in the energy crisis. Based on today's consumption rates and known reserves, the seventh grade student will be 34 or 35 years old when we run out of oil products. He or she will be 22 years old when we run out of natural gas. The student has three possible futures: (1) He or she may live an altered lifestyle designed to prolong our energy sources by conserving energy; (2) he or she may maintain the present lifestyle if renewable energy sources are developed; or (3) he or she may live a completely different lifestyle if we "run out of usable energy."

The choice is not entirely up to the student but he and she will have the responsibility of implementing decisions made now and of making new decisions about energy use. This Environmental Learning Experience has been prepared with that in mind.

The eleven concepts of the unit have been developed into eleven lessons that should take from two to three weeks to complete. Each lesson is not necessarily designed to be presented in one class period. Some of the lessons are designed for discussion. Student interest in the discussion should determine the time required to present the lesson. You will find many questions throughout the procedure part of the unit. It is hoped that these questions will provoke meaningful discussion. In some cases, the desired answer is in parenthesis.

Throughout the Pak, some projections into the future are made. All forecasts of what will happen in the future are based on assumptions based on the past and present. For example, when projecting energy use in the future, trends in standards of living must be considered. The students should be aware that projections are estimates based on assumptions that may or may not be entirely valid.

Most of the materials and equipment needed for this unit will be available in Kit form. However, it is assumed that all Junior High Schools in the district have a supply of standard laboratory equipment (beakers, ring stands, etc.). Several pages within the unit are designed for use in machines for ditto masters and transparencies. All films and filmstrips are available in our film library.

On the following page, you will find a master materials list of all necessary materials and equipment. The list is arranged by lesson.

MASTER MATERIALS LIST
For one class of 30

1	electric toy car
1	spring wound toy car
1	inertia toy car
1	wooden stick six inches long
1	large straight pin
1	sheet of construction paper
40	feet of small insulated electric wire
1	bar magnet
1	milli-volt meter or compass
1	Florence flask
1	Burner (Bunsen or alcohol)
2	ring stands
4-6	feet of large rubber tubing
	Wheels and blades from Tinkertoy set
1	Medicine dropper
1	old umbrella with handle removed
1	large roll of aluminum foil
1	250 ml beaker
1	thermometer
1	1 gallon water container
1	large aluminum cake pan
1	aquarium water wheel
1	clamp (for rubber tubing)
1	internal combustion engine model
1	old electric motor (1 or 1½ HP) or electric motor model
1	solar cell demonstration kit
1	overhead projector and marker

FILM AND FILMSTRIPS FOR LESSONS

Film - "Energy and Work" (Lesson 1)
Filmstrip - "Story of Oil" or slide set - "Oil" (Lesson 6)
Film - "Energy Crisis" (Lesson 12)

FILMS AND FILMSTRIPS FOR SUGGESTED ACTIVITIES

Filmstrip - "Natural Gas" (Lesson 6)
Film - "Freedom and Power" (Lesson 8)
Film - "How to Produce Electric Currents with Magnets" (Lesson 8)
Film - "What is Electric Current" (Lesson 8)

MATERIALS AND EQUIPMENT LIST
By Lesson

1. 3 toy cars (electric, spring, inertia)
   Ditto: Student Energy User Inventory
   (Fossil Fuel Users; Electric Users)
   Film: "Energy and Work"

2. Overhead projector and marker
   Student Energy User Inventory
   Transparency - Electrical Energy in Your Home
   Ditto: Quiz

3. Student Energy User Inventory
   Ditto: Meter recording sheets
   Ditto: Evaluative Activity
   Chart or overhead transparency of "School Master Chart"

4. Ditto or transparency of data
   Graph paper
   Ditto: Graph and work sheet

5. Instruction Dittos for each group
   Group 1
   Wooden stick about six inches long
   Straight pin
   Construction paper
   Moving air force (fan)
   Group 2
   40 ft. of thin insulated wire
   Bar magnet
   Milli-volt meter or compass
   Group 3
   Florence flask
   Burner (Bunsen or alcohol)
   Ring stand (2)
   Rubber tubing (1½ feet)
   Wheels and blades from Tinkertoy set
   Medicine dropper
   Group 4
   Old umbrella with handle removed
   Aluminum foil
   Beaker (250 ml)
   Thermometer
   Group 5
   Two water containers (1 gallon bucket and 1 cake pan)
   Large rubber tubing (3 or 4 feet)
   Aquarium water wheel
   Clamp

6. Filmstrip "Story of Oil" or slide set "oil"

7. Internal combustion model
   Electric motor model
   Efficiency of Energy converters
   Ditto: Quiz

8. Transparency: Flow diagram of Centralia Steam Electric Power Plant
   Transparency: Cross section of Ross Dam

9. Material Packet of "Hi Ross Dam"
   Material Packet of "North Cascades Conservation Council"

10. Student Energy User Inventory

11. Solar cell demonstration kit
    Overhead transparencies
    1. Wind as a power source
    2. Solar Collector

LESSON 1

CONCEPT: The development of energy takes many forms.

MATERIALS: Film "Energy and Work"
Three toy cars about the same size (1 electric, 1 spring, 1 inertia)

NOTE TO TEACHER: The purpose of this lesson is to introduce the concept "Energy" to the students. The main concept involved in this Pak is the energy aspects of Man's Environment, not the physical aspects of Energy. However, the term or concept "Energy" is abstract. Therefore, the students should have a general understanding of the concept.

PROCEDURE:

1. Introduce the topic Energy by doing the following activity:
   a. Hold up the three cars for inspection by the students.
   b. Provide the three cars with energy needed for movement.
   c. Ask: *What do the cars have in common.*
      Possible answers: (1) motion (2) speed (3) energy
   d. The response to the above question will determine your next procedure. Channel the discussion towards the response "Energy".
   e. Ask: (1) *What is energy?*
      (2) *Can you see energy?*
      (3) *Can you feel or smell energy?*
      Leave the discussion open.
   f. Ask: *Which car has the most energy?*
      How could we find out?

2. Show the film "Energy and Work".

3. The rest of the class period should be used to introduce the next lesson. The discussion should be centered around the theme, "Student, User of Energy". Leading questions such as the following could be used:
   (1) *Do you use energy?*
   (2) *How?*
   (3) *What kind of energy do you use?*

   Make a list on the chalk board of the different kinds of energy students use:
   Examples: electricity, food, gasoline, heating oil, natural gas, etc.

Assignment: Instruct the students to inventory their home for energy using devices. Have the students fill out the first three columns of the student inventory ditto. For electrical appliances, the student will need to know the amount of energy used by each appliance in the form of watts. Most appliances are labeled in watts. However, if the number of watts cannot be found, watts can be calculated by multiplying volts and amperes. (W = V x A) The student will also need to estimate the amount of time each appliance is used per day in hours.

The fossil fuel inventory should include all fossil fuel users. The student could ask his parents to help in estimating the amount of fossil fuel used per day.

Instruct the students not to attempt the math computations necessary to complete the inventories. This will be done in lesson 2. These inventories will also be used again in lesson 10.

EVALUATIVE ACTIVITY: See Lesson 2

SUGGESTED EXTRA ACTIVITIES:

1. How much force is required to lift a book off the table?

2. Investigate friction as a force:
   Using a spring scale and a wood block, determine the factors that affect the amount of friction an object exerts. Examples: roughness of surface, amount of surface area, mass of the block.

3. Use a balance rod to determine the input work and the output work of a system. Input work is always greater than output work because of friction.

4. Use pulleys to demonstrate the mechanical advantages of pulleys.

5. Have the student compare different techniques of accomplishing the same thing. For example, lifting a 1og mass 1 meter high directly, using an incline plane, and using pulleys. Compare the amount of work necessary in each case.

ELECTRIC USERS

1	2	3	4
Energy User	Power (Watts)	Time used per day (hours)	Energy used per day (Watts X hours)
Kitchen Stove and Oven			
Hot Water Heater			
Clothes Washer			
Clothes Dryer			
Refrigerator			

FOSSIL FUEL USERS

(Oil, gasoline, natural gas, coal)

1 Energy User	2 Type of Energy	3 Gal. used per day	4 Convert Gallons to Kilowatt hours (gal. X 37)
Automobile			
Oil Furnace			
Lawn Mower			

LESSON 2

CONCEPT: How much energy does the student and his family use?

MATERIALS: Student "Energy User" Inventory
Overhead projector and marker
Transparency - Electrical Energy in your Home
Ditto - Quiz

PROCEDURE:

1. In order to understand and compare amount of energy, the units of energy must be discussed. Electricity is generally measured in terms of watts. To determine the amount of electricity an object will use, multiply amperes by voltage. For the purpose of this Pak, the student need not understand the mechanics of determining the number of watts, but he should understand that amounts of electricity can be measured and that the standard unit is the watt (see list of common energy and power units).
   a. Begin the discussion by mentioning several common units (pounds, gallons, feet, meter, etc.) or by asking leading questions about these units. Example: *When buying gasoline for the car, what unit is the gasoline measured in?*
   b. Continually emphasize the term Unit and that everything that is measured is measured in a unit of some kind.
   c. *Can electricity be measured?*
   d. *If it were possible to buy electricity from the grocery store, how would you tell the grocer how much you want?*
   e. Answer - You would place your order in watts.
   f. Discuss the concept that a watt is a very small amount of electricity, therefore, the prefix kilo, meaning 1000, can be added to indicate a larger amount of electricity, the Kilowatt.

2. *Can we use your inventory to calculate the amount of electricity used per day?*

3. Analyze the student "Electric Users Inventory". Compare several common appliances with an average appliance. (See list accompanying unit). Use an overhead transparency. If a student could not determine the watts of a particular appliance, have the student use the figure on the overhead transparency or use the list accompanying this lesson.

4. The students will need to calculate the amount of electricity each appliance would use in hours per day. Many students will find the math computations difficult. Keep in mind that the math is secondary to the main concept of this lesson. However, it is important that the students arrive at a reasonable estimate.

   a. Pass out the instruction sheet. Read the instructions or have the students read the instruction sheet to the class. Go over all examples step by step. Have the students do the calculations as you go.

b. Check each inventory to determine if the estimate is reasonable. The answer should be between 25 and 45 kw-hrs.

Below are some suggestions that might help the students through this difficult task.

a. Team-teach this lesson with a math teacher.

b. Have the more capable math students help the less capable students.

c. If available, use electronic calculators. Have a slide rule handy.

d. If all else fails have the students use the figures in the list accompanying this lesson.

5. *Is electricity the only kind of energy we use?*

6. Analyze the fossil fuel inventory.
   a. In order to compare and add different forms of energy, a common unit must be used.
   b. Ask: *Are these forms of energy measured in watts?*
   c. *What units are used for gasoline, heating oil, natural gas.*
      (Answer - gasoline and heating oil - gallons; natural gas - cubic feet).
   d. Discuss the problem of trying to add two or three different units together.
      Analogy: (1) trying to add oranges and apples
      (2) trying to add gallons and pounds
   e. If we could change all of the energy in a gallon of gasoline to electricity we would get 37 kW-hours of electricity. Therefore, we can convert gallons of gasoline used to its electric equivalent by multiplying gallons used by 37. We can convert heating oil by multiplying gallons used by 41.2, and natural gas by multiplying cubic feet used by .31.
   f. Have students convert all fossil fuel used to kW-hrs. Add total.

7. Convert electricity used from watt-hours to KW-hrs by dividing by 1000.

8. Add electricity used to fossil fuel used to get an estimate of the energy used for the day for the household.

EVALUATIVE ACTIVITY: Quiz over first two lessons (see next page)

SUGGESTED EXTRA ACTIVITIES: Students could inventory his home block to determine the percentage of homes that use electricity, oil, or natural gas for water heating, space heating, and cooking.

The student could write a report or make a mural on the historical progression of energy use.

The students could work in small groups to manufacture an object recording types and uses of energy. Suggested objects: candles, clay beads, mobiles.

MATCHING:

1.	________________ the capacity to do work.	a.	Watt
2.	________________ force X distance.	b.	Gallon
3.	________________ the basic unit of measure for electricity.	c.	Work
4.	________________ the basic unit of measure for gasoline.	d.	Energy

5. Suppose you had used 30,000 watt hours of electricity on a given day. How many kilowatt-hours did you use?

6. Convert 4 gallons of gasoline to it's electric equivalent (KW-hrs.).

Teacher Resource
Some Common Energy and Power Units

Energy

kilowatt-hour (kW-hr) = 3,600,000 joules (J) = 3.6×10^6 J

calorie (cal) = 4.186 J

food calorie - kcal - 1000_{cal}

kilocalorie (kcal) = 4186 J

British thermal unit (Btu) = 252 cal = 252 (4.186) J = 1050 J = 2.92×10^{-4} kW-hr

Power

3,413 Btu/hr = 1 watt (W)

kilowatt (kW) = 1000 W = 10^3 W

megawatt (MW) = 1,000,000 W = 10^6 W

gigawatt (GW) = 1,000,000,000 = 10^9 W

1 Watt = 1 Joule/sec

Energy Equivalents

1 gallon gasoline = 126,000 Btu = 1.26×10^5 Btu = 3.7×10^1 kW-hr = 37 kW hr

1 pound bituminous coal = 13,100 Btu = 1.31×10^4 Btu = 3.8×10^0 kW-hr = 3.8 kW hr

1 cubic foot natural gas = 1,050 Btu = 1.05×10^3 Btu = 3.1×10^{-1} kW-hr = .31 kW hr

1 42-gallon barrel of oil = 5,510,000 Btu = 5.51×10^6 Btu = 1.6×10^3 kW-hr = 1600 kW hrs

1 gallon #2 heating oil = 141,200 Btu = 1.412×10^5 Btu = 4.12×10^1 kW-hr = 41.2 kW-hrs.

ELECTRICAL ENERGY IN YOUR HOME

Appliance	Power (Watts)
Stove and oven	12,000
Hot water heater	4,000
Clothes dryer	4,000
Clothes washer	1,000
Food disposal	1,000
Dishwasher	1,400
Refrigerator	1,000
Freezer	1,000
Iron	1,000
Toaster	1,000
Blender	700
Food mixer	200
T.V. - color	350
T.V. - black & white	200
Stereo	300
Table radio	50
Electric razor	15
Toothbrush	15
Can opener	200
1 horsepower motor	750

Average daily home use - 33,360 Watt hours = 33.360 Kilowatt hours each day

For the year, about 12,000 kW-hr.

Lighting adds another 1,000 kW-hr per year.

Electric living costs about 13,000 kW-hr per year.

Electric heat is another 15,000 kW-hr per year.

Air conditioning in much of the U.S. uses 10,000 kW-hr/year.

ESTIMATED ANNUAL AND DAILY KWH USE FOR VARIOUS ELECTRICAL APPLIANCES

NOTE: These uses are those calculated for an average family of four for an average number of hours

Appliance	Average Watts	Annual Hours of Operation	Daily Hours of Operation	Annual KWH Use	Daily KWH Use
Air Conditioner (varies considerably with area, degree days and family living habits)					
Window				935	2.56
Per 1000 BTU				135	.37
Central				2400	6.58
Blanket	190	970	2.6	180	.49
Bottle Warmer	500	72	.2	36	.10
Broiler	1400	70	.2	100	.27
Can Opener	10	5	.01	1/	
Carving Knife	95	8	.02	8	.02
Clock	2	8760	24	18	.05
Clothes Dryer	4600	240	.7	1100	3.01
Coffee Maker	800	180	.5	145	.40
Corn Popper	525	2	.005	10	.03
Dehumidifier	260	1460	4	380	1.04
Dishwasher 2/	1200	360	1	430	1.18
Egg Cooker	500	28	.08	14	.04
Fans					
Attic	370	785	2.2	290	.79
Circulating	90	500	1.4	45	.12
Kitchen	250	360	1	90	.24
Roll-about	170	825	2.3	140	.38
Window	200	850	2.3	170	.47
Floor Polisher	350	70	.2	25	.07
Food Blender	350	36	.1	125	.34
Food Freezer - 15 cu. ft.					
Standard	350	3425	7.4	1200	3.29
Frost Free	440	4000	11	1760	4.82
Food Mixer	125	70	.2	9	.02
Food Warming Tray	350	200	.55	70	.19
Food Waste Disposer	450	65	.2	30	.08
Fry Pan	1150	300	.8	345	.91
Fryer, Deep Fat	1500	50	.14	75	.20
Furnace (varies considerably with area, degree days and family living habits)					
Oil	500	800	2.2	400	1.10
Gas	500	800	2.2	400	1.10
Electric				13500	36.99
Germicidal Lamp	20	7000	19	140	.38
Griddle	1450	70	.2	100	.27
Grill, Sandwich	1160	30	.08	35	.10
Hair Curler	1100	100	.27	110	.30
Hair Dryer	400	60	.16	25	.07
Heat Lamp	250	60	.16	15	.04
Heater					
Portable	1000	1080	2.95	1080	2.96
Radiant	1270	135	.37	170	.47
Heating Pad	65	120	.33	8	.02
Hot Plate	1250	72	.2	90	.25

Appliance	Average Watts	Annual Hours of Operation	Daily Hours of Operation	Annual KWH Use	Daily KWH Use
Iron	1100	145	.4	160	.44
Ironer	1500	145	.4	220	.60
Lawnmower	1000	100	.27	100	.27
Lighting (varies with size of home & living habits)					
Night Light	10	2900	4.9	29	.08
Post Light (Photo Cell)	100	4200	11.5	420	1.15
Projector					
Slide	500	50	.14	25	.07
Motion Picture	700	50	.14	35	.10
Radio					
Console	75	1400	3.8	105	.29
Table	50	1400	3.8	70	.19
Radio-Phonograph	110	1000	2.7	110	.30
Range	12000	100	.27	1200	3.29
Self Cleaning Oven	4000	50	.14	200	.55
Razor	15	60	.16	1	.003
Record Player					
Console	160	300	.8	50	.14
Table	75	300	.8	25	.07
Recorder	100	100	.27	10	.03
Refrigerator - 12 cu. ft.					
Standard	240	3125	8.6	750	2.05
Frost Free	320	3800	10.4	1220	3.34
Refrigerator-Freezer - 14 cu. ft.					
Standard	325	3540	9.7	1250	3.42
Frost Free	360	5150	14.1	1850	5.07
Roaster	1320	360	1	475	1.30
Rotisserie	1400	360	1	500	1.37
Sewing Machine	100	120	.33	12	.03
Sun Lamp	300	50	.14	15	.04
Television					
Black and White	240	1500	4.1	360	.99
Color	350	1500	4.1	525	1.44
Toaster	1150	48	.13	55	.15
Toothbrush	5	10	.03	1/	
Vacuum Cleaner					
Portable	210	60	.16	13	.04
Standard	600	120	.33	70	.19
Vibrator	40	50	.14	2	.005
Waffle Iron	1100	24	.07	26	.07
Washer 2/					
Automatic	500	200	.55	100	.27
Nonautomatic	285	200	.55	75	.21
Water Heater (varies considerably with clothes washing and bathing habits)				4800-9600	13.15-26.30

1/ Less than 1 kwh
2/ Does not include electricity to heat water.

Instructions for calculations for the Electrical Inventory.

In order to figure out the amount of electricity you use each day, some calculations are necessary. Please follow these instructions and be very careful with your math. If you have a problem you can not solve ask your teacher for help.

1. First of all we must be sure that all "times used per day" figures (column 3 on your inventory) are in hours, not minutes. For example there are many appliances that are used for less than one hour each day. Some appliances will be used only one time a week, or even less. We must convert the times these appliances are used into the average time in hours used per day.

   The following examples will help you make the calculations.

   a. Suppose you look at your inventory and you find that the toaster is used 15 minutes a day. We must convert 15 minutes to a part of an hour. Since there are 60 minutes in one hour, 15 minutes equals $\frac{15}{60}$ hours. Reduce the fraction $\frac{15}{60}$ to $\frac{1}{4}$ hour. Change the figure on your inventory to read 1/4 hour.

   b. Suppose the family uses the electric tooth brush 20 minutes each day.
      20 minutes = 20/60 hour = 1/3 hour

   c. Suppose the family uses the electric range 3 hours, 10 minutes each day.
      3 hrs., 10 minutes = 3 10/60 hours = 3 1/6 hours.

   d. Your parents use the electric knife 1 time a week for 15 minutes. We need to find out how much proportional time it would be used each day in hours.
      1) Divide 15 minutes by 7 days a week to find out how many minutes the knife would be used each day.
         15 ÷ 7 = 2 1/7 minutes a day
         Round off to 2 minutes a day.
      2) Convert 2 minutes to a part of an hour
         2 minutes = 2/60 hours = 1/30 hours.

   Recheck your inventory to be sure that all figures are converted into hours or parts of an hour before going on. Have your teacher look at your inventory.

2. Now we must figure out how much electricity each appliance uses per day. We can do this by multiplying watts (column 2) by hours used (column 3). Put your answer in column 4.

   The following examples will help you in your calculations.

   a. Suppose the hair dryer uses 500 watts 1 hour a day. The energy used each day would be 500 watts times 1 hour which equals 500 watt-hours.
      energy used = watts x hours
      = 500 x 1
      = 500 watt-hours

b. The hot water heater uses 5,000 watts and operates 3 hours a day.

energy used = watts x hours
= 5000 x 3
= 15,000 watt-hours

c. The toaster uses 1150 watts for 1/2 hour each day.

energy used = watts x hours
= 1150 x 1/4
= $\frac{1150}{4}$ = $4\overline{)1150}$
= 287½ watt-hours

3. Next add the energy used by all the appliances. (all of column 4) Put your answer near bottom of column 4.

4. Finally we must convert the watt hours to kilowatt hours. Remember that "kilo" means 1,000. Therefore, 1 kilowatt-hour equals 1,000 watt-hours. We can convert your total watt-hours to kilowatt hours by dividing by 1,000. Suppose your family uses a total of 33,000 watt-hours each day.

kW-hrs. = 33,000.0 wt.-hrs ÷ 1,000
= 33.0

Notice that we simply moved the decimal point three places to the left. You use 36,400.0 watt-hours a day.

kW-hrs. = wt-hrs ÷ 1,000
= 36,400.0 ÷ 1,000
= 36.4

Now you should have a good idea of how much electricity you use each day. When you are finished with your calculations have your teacher check your inventory.

LESSON 3

CONCEPT: How much energy does home, school and community use.

MATERIALS: Students' inventories
Ditto: Meter recording sheets
Chart or overhead transparency - School Master Chart
Ditto: Evaluative Activity

PROCEDURE:

1. Complete the students' inventories
   a. Ask *Are there any energy users that we have omitted from the inventory?*
      1) Lighting - Since the use of electricity for lighting is difficult to estimate, the student should add to his total the average, about 2.7 KWH per day.
      2) Food - Ask *How much energy do we consume in the form of food? How could we find out?* This could be determined by counting Calories (kilocalories) and converting to its electric equivalent in KWH.
         Example: A student consumes about 2150 kilocalories of food per day.
         1 KWH = 860 kilocalories
         KWH/person = 2150 ÷ 860
         = 2.5
         Since the process of counting calories is time-consuming and somewhat complicated, have the students use 2.5 KWH per person as an estimate. Multiply 2.5 KWH/person by the number of people in the family for the family total. Have student add this figure to the total on his inventory.
      3) Other possible energy uses. Ask *Have we omitted any other uses of energy around the home?*
         Examples: fireplace, gas yard lights, camping equipment, etc.
   b. Calculate the yearly use of energy by multiplying the inventory totals by 365.

2. The above total should give the student an idea of how much energy he and his family uses. The scope of the students' understanding should be broadened to include energy used by community and county.

   Discuss methods that could be used to calculate the amount of energy used by the households of the students in the class. Expand the discussion to include the households of all students in the school, the school district, the community, and the county.

   a. Add up the totals of all the students in the class.
   b. Determine the number of households represented by students in school.
   c. Determine number of households in the school district, community and county.
   d. Add up all of the inventories. Emphasize that this represents only domestic energy use.

   Ask: *Is this an easier way to determine how much electricity we use?*
   Answer: Read the meter.

3. Determining the school's energy use.

   a. Discuss methods of determining the school's energy use.
      How much energy does the school use? How could we find out?

      1) Electricity - Read the meter for a specified time.
      2) Heating Oil - ask the custodian or office for usage/month.
      3) Other possible energy users. Example - bottled gas for shop, science lab, etc.

   b. Set up a schedule for determining the school's energy use.

      1) It might be necessary to show students how to read the meter.
      2) Divide class into six groups. Assign one week day to each of five of the groups.
      3) Instruct each group to read the school meter on their day and record the reading on a master chart in the classroom. (See accompanying page)
      4) Instruct the other group to obtain the necessary information to determine the amount of heatin oil used per week.

   c. To compare the school's energy use to home use, have each student keep a daily record of the meter reading on his home. Also have each student determine the amount of energy used for heating for one week. (Heating oil, natural gas, etc.)

EVALUATIVE ACTIVITY: Have student complete the ditto on the following page.

SUGGESTED EXTRA ACTIVITIES:

1. How much energy does the entire school district use per day, per year?

2. How does industry use energy? Students could draw a flow diagram of a specific industry (steelmaking, aluminum, glass, rubber, etc.) indicating where energy is used, wasted, etc.

3. Calculate the amount of energy used to manufacture an aluminum can or glass bottle.

Use the following information to determine the amount of electricity used for the five days indicated.

Electricity

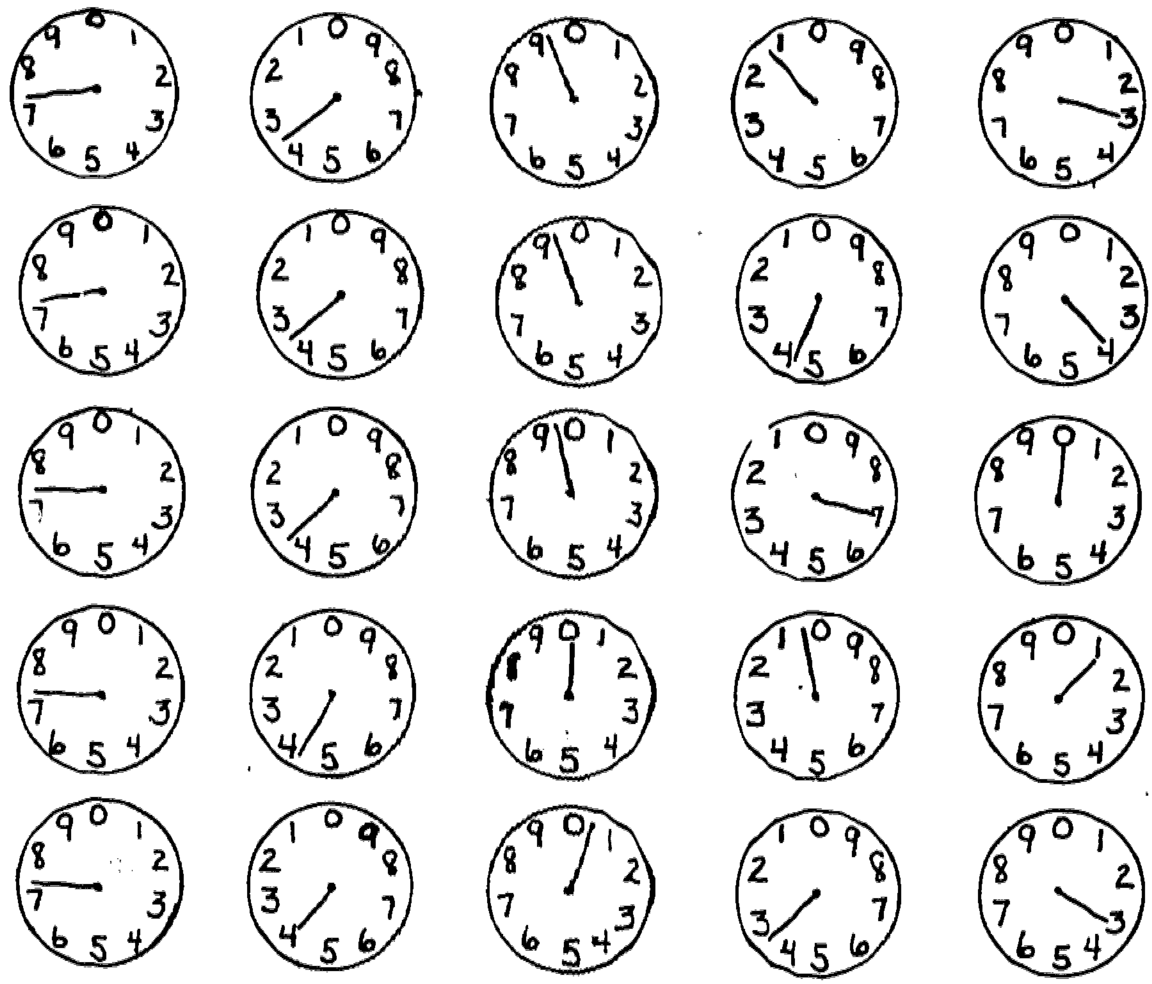
Monday

Tuesday

Wednesday

Thursday

Friday

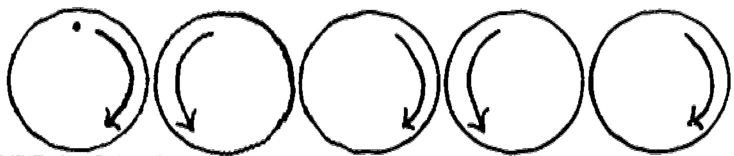


Day	Meter Reading	Amount Used (KW-hrs)
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		
Total		

STUDENT METER RECORDING SHEET

Name: ______________________________

Date	Reading (KW-Hr.)	Change



SCHOOL MASTER CHART

Date	Meter Reading	Energy Used

Total Electricity used ____________________ KW-hrs

Heating Oil used (gallons) ____________________

Conversion factor ____________________

Kilowatt-hour equivalent ____________________

Total Energy used ____________________ KW-hrs

CONCEPT: Energy use in the United States

MATERIALS: Ditto - Evaluative Activity
Graph paper
Ditto or transparency of data

PROCEDURE: 1. The student will graph the following data to obtain a basic understanding of the major energy users and the amount each uses. (Oil, Natural Gas, and Electricity).

a. Data - Energy Sales (Billions of KW-hrs.)

Type of use	Year				
	Actual			Projected	
	1950	1960	1970	1980	1990
Domestic (Home use)	5.5	13.8	27.5	47.5	77.7
Commercial	2.4	5.2	12.1	22.5	38.3
Industrial	11.1	22.3	44.1	74.7	118.0
Total	19.0	41.3	83.7	114.7	234.0

Data from Energy & Man's Environment, page 9. Originally from Bonneville Power Authority 1971 Status Report

b. Discuss how data is obtained.
   1) Add all the light bills, oil bills, and gas bills for individual housing units, apartments, etc. for the total domestic use. Refer back to the student's inventories and expand on it.
   2) Commercial use includes all electricity, gas, and oil used in grocery stores, business offices, etc.
   3) Industrial users include all manufacturing facilities, power plants, oil production, etc.

c. Point out that the projected usage for 1980 and 1990 are only estimates, and that these estimates are made by assuming certain trends and situations. The assumptions may or may not be valid.

d. Have students make a bar graph of the data.
   1) Students might need help in setting up the graph. Set up the graph as per example on the following page.

2. Analyze the graph by having students answer the following questions:
   a. *Has energy use or consumption increased from 1950 to 1970?* (Increased)
   b. *Of the three consumers, which one uses the most energy?* (Industry)
   c. *Estimate the amount of energy industry will use in 1974.* (60,000,000,000 KW-hrs.)
   d. *Which of the three is increasing its energy use most rapidly?* (Commercial
   e. *List 3 reasons that domestic (household) energy use is increasing.*
      1. More households
      2. More energy using appliances
      3. More automobiles, TV's per household
   f. Complete the period with a discussion of the above questions. Point out the following:
      1) Energy consumption is increasing at a very rapid rate.
      2) That industrial use is increasing because we are demanding more material goods which have to be manufactured.
      3) More work is being done by machine instead of by hand.
      4) Much energy is consumed for convenience purposes.

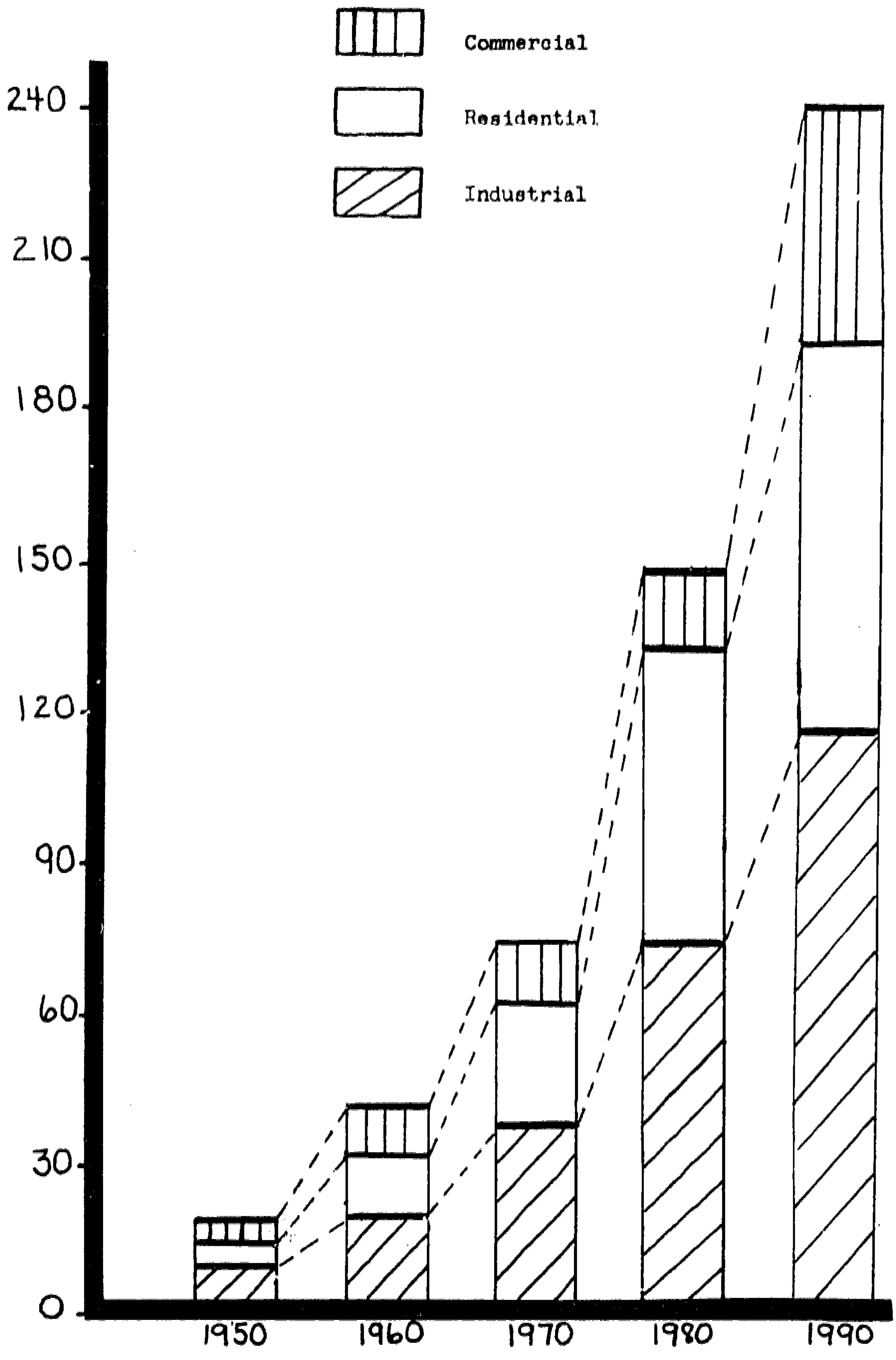
EVALUATIVE ACTIVITY: See ditto. This activity can be used as an evaluative activity or as an additional lesson. At any rate the activity should be discussed in class. The students may need help in reading the graph. The students should interpret the graph by answering the questions.

SUGGESTED EXTRA ACTIVITIES:

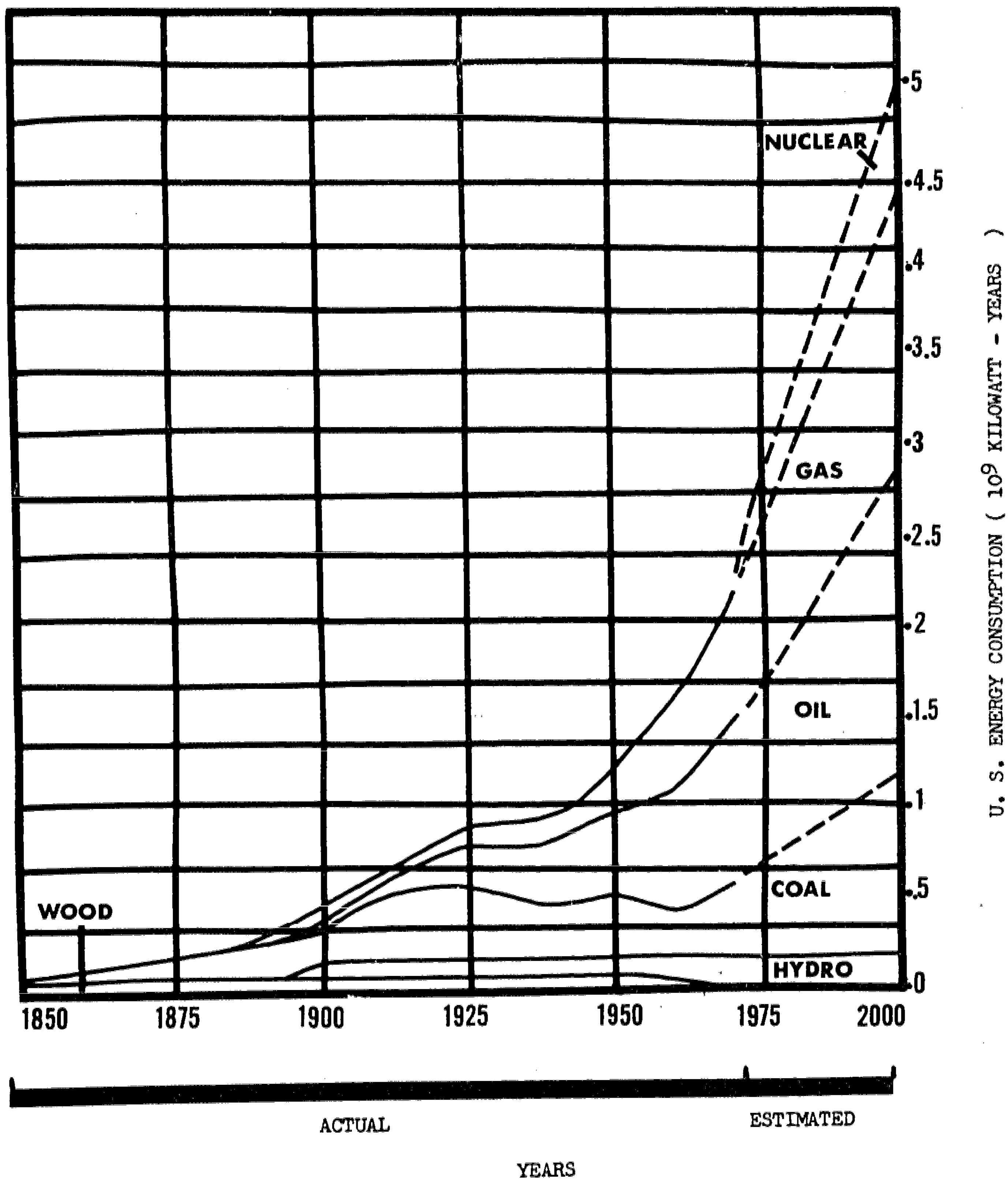
1. The student could describe the process of manufacturing a bicycle, including an inventory of all energy used.

2. The student could compare the quantities of energy used by basic manufacturing industries such as aluminum, iron, etc.

Set up the graph as follows:



USE THE GRAPH TO ANSWER QUESTIONS



TRUE OR FALSE

_____ 1. During the period between 1870 and 1970 there was an increase in the amount of energy used in the United States.

_____ 2. During 1870 and 1970 the amount of wood fuel used in the United States decreased.

_____ 3. It could be generalized that the amount of coal used for energy between 1870 and 1970 decreased.

_____ 4. During the period between 1910 and 1930 there was a lesser increase in energy consumption than between 1930 and 1970.

_____ 5. During 1970, the amount of energy used about equals the total amount used in both 1930 and 1950.

Complete the following statements:

6. The primary source of fuel in 1910 was ____________________.

7. In the year of ____________ wood fuel was the primary source of energy.

LESSON 5

CONCEPT: Renewable sources of energy

MATERIALS: Instruction dittos
See material lists for each activity

PROCEDURE: The students will investigate some of the methods of producing energy. In order to offer a wide variety of processes, divide the class into 5 groups and assign each group a different process. Allow the students about 30 minutes to construct their "energy producer," and to prepare a demonstration for the rest of the class. Pass out the instructions to the appropriate group. In all activities emphasize the demonstration, not the actual construction of the energy producers.

EVALUATIVE ACTIVITY: Have each student choose one of the five methods and sketch and describe how his chosen energy producer could be put to work. Suggestions:
1. Electricity generation
2. Grain grinder
3. Pumping water

The student should:
1. describe his process
2. discuss the advantages and disadvantages
3. discuss the limitations

SUGGESTED EXTRA ACTIVITIES:

1. A small electric motor could be used as a generator for all methods except number 2. The voltmeter could be used to measure voltage.

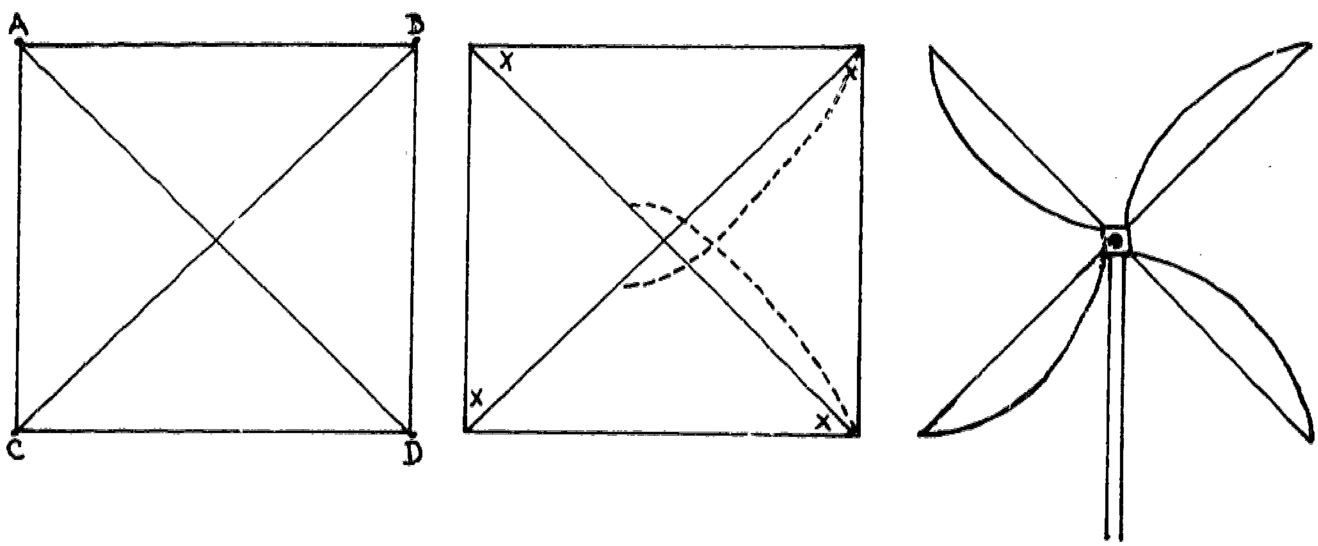
2. Using a large bowl lined with aluminum foil, bake a potato using solar energy.

3. Create an electric current by inserting a strip of copper and a strip of zinc into a lemon. Squeeze the lemon first to soften it. Then insert the strips so that they do not touch each other. Attach wires to each strip and connect the wires to the millivoltmeter or compass. Discuss to what extent this energy source is renewable.

GROUP 1 - Windmill

MATERIALS: Wooden stick about six inches long
Straight pin
Construction paper
Moving air force (fan, etc.)

PROCEDURE:
1. Cut a piece of construction paper to a 6" square.
2. Draw diagonal lines from A to D and from B to C. (see sketch).
3. Cut to within ½" of point from four corners along these diagonal lines.
4. Fold points X to center and put the pin through S and the center where lines cross.
5. Attach pinwheel to the end of the wooden stick by forcing the point of the pin into the stick.
6. Blow into the center of the pinwheel or hold pinwheel in any current of air.

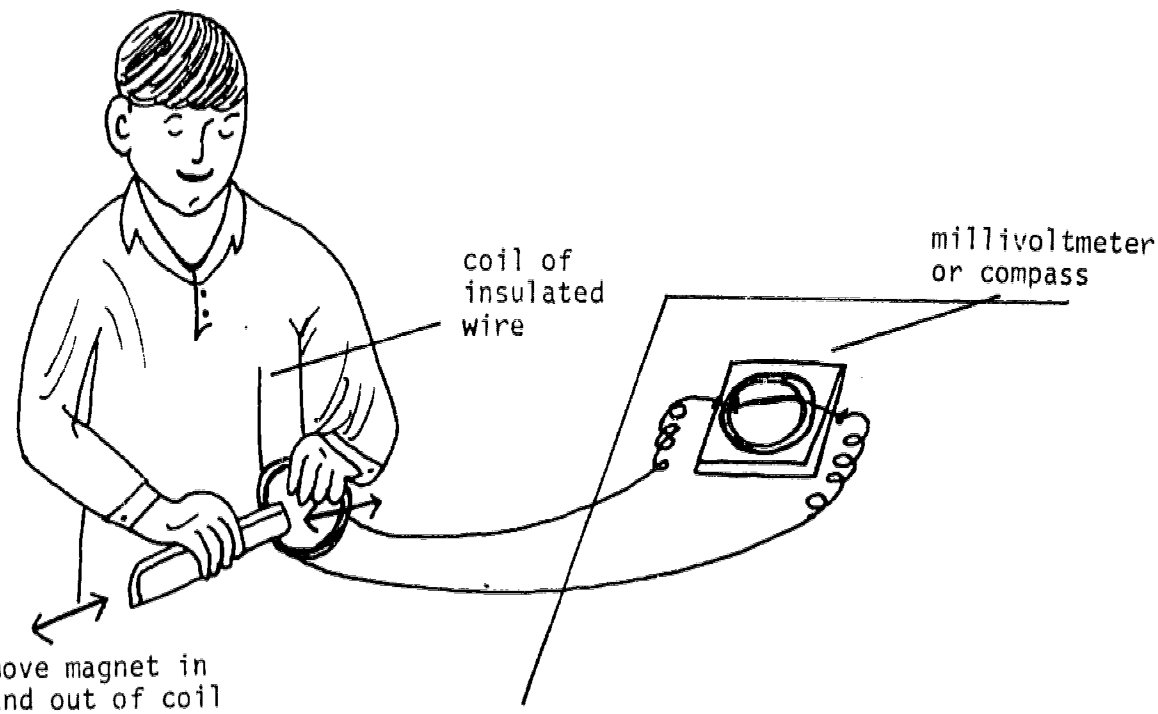


DEMONSTRATION: Organize your demonstration along the following lines:

1. *What makes the windmill turn?* (Principle)
2. Make a sketch showing how the motion of the windmill can be converted into some kind of beneficial work.
3. *What kinds of work can be done with windmills?* Suggestions: (Pumping water, generating electricity, grinding grain.)

GROUP 2 - Electricity Maker

MATERIALS:
- 40 feet of thin insulated wire
- Bar magnet
- Millivoltmeter or compass



FROM: Barr, George, More Research Ideas for Young Scientists McGraw-Hill, 1961.

PROCEDURE:

1. Wind a 1½" coil of about 50 turns of thin insulated wire.
2. Tie or tape to prevent unraveling.
3. Attach ends of the wire to the voltmeter. (Connecting wires must be 3 or 4 feet long.)
4. Insert a strong magnet into the coil.
5. Read amount of voltage registered on the voltmeter.

DEMONSTRATION:

1. Demonstrate principle:
   a. Faraday's Principle - when a wire cuts a magnetic field an electric current is produced in the wire.
   b. Demonstrate that movement is necessary. Holding the magnet still will not produce movement.

2. Demonstrate that amount of current can be increased by more rapid movement.

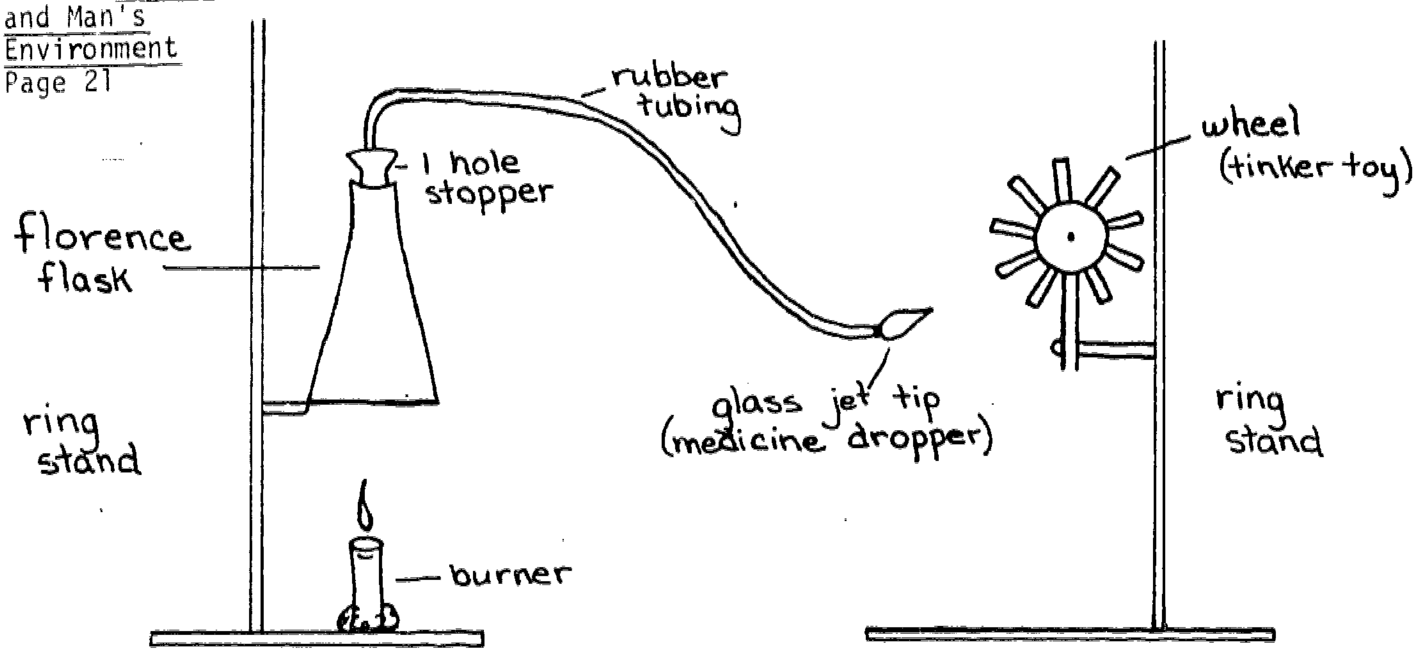
3. Demonstrate that movement of either the magnet or the wire will produce current.

GROUP 3 - Steam engine

MATERIALS: Florence flask
Burner (Bunsen or alcohol)
Ring Stand (2)
Rubber tubing (1½ feet)
Wheels and blades from Tinkertoy set
Medicine dropper

PROCEDURE: 1. Construct the model using the following diagram

FROM: Energy and Man's Environment Page 21



2. Boil water in the flask.
3. Direct steam at wheel

DEMONSTRATION: 1. Demonstrate principle
   a. When water boils, it expands forcing steam out of flask.
   b. Steam under pressure aimed or concentrated can do work. (turning wheel)
2. Sketch process where this "steam engine" is performing useful work.
3. Discuss that energy must be used to boil the water.
4. Discuss methods of providing this energy.
   a. Coal
   b. Oil
   c. Natural gas
   d. Geothermal - using earth heat to make steam
      Example: tapping Mt. Rainier
   e. Solar - concentrating solar energy on water container

GROUP 4

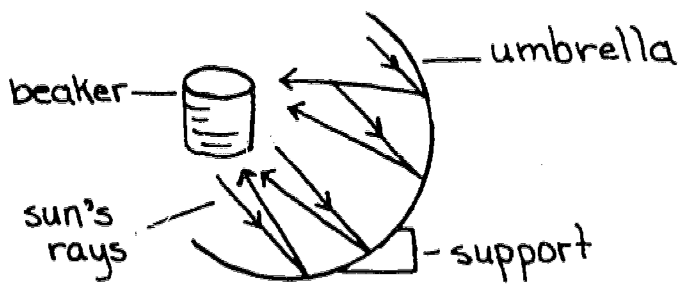
MATERIALS: Old umbrella with handle removed
Aluminum foil
Beaker
Ringstand for holding beaker
Thermometer

PROCEDURE:

1. Line the inside of the umbrella with aluminum foil, shiny side out. (Use a ball or spoon to smooth out wrinkles).
2. Set up umbrella in bright sunlight aimed at the sun.
3. Position beaker filled with water at the focal point of sun's energy.
4. Read and record temperature of water at 5 minute intervals.

DEMONSTRATION:

1. Demonstrate principle
   a. Sketch on chalk board



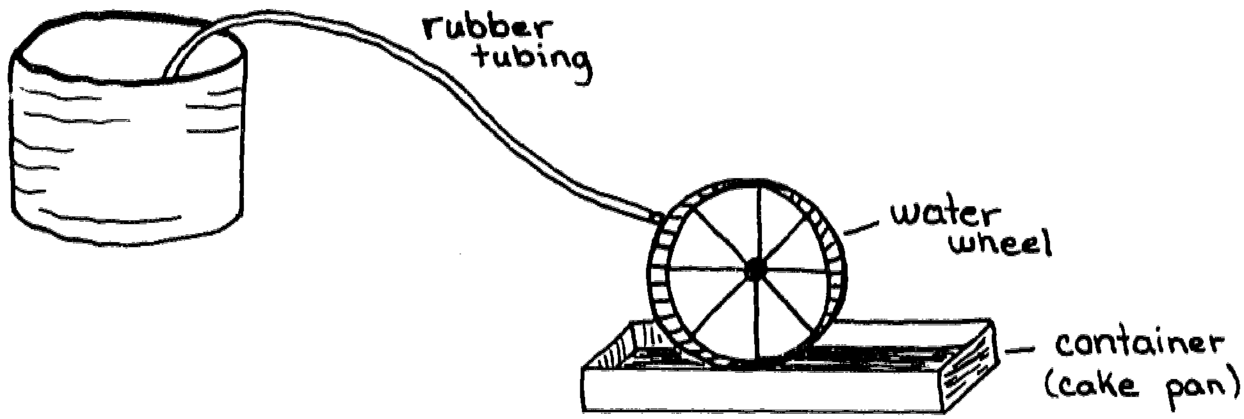
   b. The sun's rays are reflected by the aluminum foil to a central point, concentrating the sun's energy, which causes the temperature of the water to increase.

2. Suggest methods of converting the concentrated energy to useful work.
   Examples: boiling water
   heating homes
   cooking
   melting metal

GROUP 5 - Hydro power

MATERIALS: Two water containers
Large rubber tubing (3 or 4 feet)
Aquarium
Water wheel
Clamp

PROCEDURE: 1. Set up equipment as in the following diagram.



2. Syphon water out of upper container and allow water to run over waterwheel.
3. Experiment with ways to change the speed of the water wheel.
   a. Raise upper container to a higher position.
   b. Use clamp to restrict flow.
4. Determine rate of revolution by counting number of times the wheel turns in one minute.

DEMONSTRATION: 1. Demonstrate Principle.
   a. Water in upper container has gravitational energy because of it's height.
   b. This energy can be utilized by having the flow of water turn a wheel.

2. Suggest ways of converting the energy into useful work.
   a. turn electric generator
   b. turn grinding wheel

LESSON 6

CONCEPT: Non-renewable sources of energy

MATERIALS: Filmstrip - "Story of Oil" or
Slide Set - "Oil"

PROCEDURE:

1. Discuss lesson 5 pointing out the following:
   a. That all of the sources of energy used are renewable sources (not used up).
   b. Ask *To what extent were these sources used in the past?*
   c. *To what extent are they used now.*
   d. Continue to emphasize that these sources are renewable.

2. Contrast the terms renewable and non-renewable.
   renewable - energy sources that are quickly replenished.
   non-renewable - energy sources that are not replenishable or sources that take a long period of time to replenish (fossil fuel).

3. Show filmstrip "Story of Oil" the story of one kind of fossil fuel.

4. Emphasize that oil is non-renewable.
   a. Ask: *Is it possible that we will run out of oil?*

5. Make a list on chalkboard of other non-renewable sources of energy.
   a. coal
   b. natural gas
   c. nuclear fuel (Fission of Uranium)

6. Make a list of the uses of fossil fuels on the chalkboard. Speculate on what would happen if those products were no longer available.

EVALUATIVE ACTIVITY: Have the student describe changes in his family's activities for an average day if they had no automobile.

SUGGESTED EXTRA ACTIVITIES:

1. A student could demonstrate the operation of an internal combustion engine.
2. Compare the advantages and disadvantages of an internal combustion engine with those of an electric motor supplying the same power. (Use a model airplane engine for the internal combustion engine).
3. Construct a chart showing the transition from plants to coal: Plant material - peat - lignite - bituminous - coal - anthrocite coal.
4. Show the filmstrip "Natural Gas".
5. If cloud chambers are available, do radioactivity experiments or demonstrations.

LESSON 7

CONCEPT: The conversion of energy

MATERIALS: Internal combustion model
Electric motor model
Transparency - Efficiency of energy converters

PROCEDURE: The purpose of this lesson is to demonstrate that energy can be converted from one form to another. However, each time energy is converted some of the energy is "lost" as heat. In other words, energy sources that come from converted energy are not 100% efficient. The efficiency of an energy system can be calculated using the following formula:

$$\text{Efficiency \%} = \frac{\text{Energy output}}{\text{Energy input}} \times 100$$

No energy converter is 100% efficient. However, some energy converters are more efficient than others. Therefore, we will contrast different kinds of energy converters.

1. Begin the discussion by demonstrating the internal combustion engine model.
   a. Ask *What kind of fuel does this kind of engine use?* (Gasoline)
   b. *How does gasoline provide energy to make the engine work?* (Gasoline burns, explodes)
   c. In other words, a chemical reaction takes place when gasoline burns. Stored chemical energy is converted to heat.
   d. *What happens next?* (the piston is forced down)
   e. The heat released by the explosion causes the air in the cylinder to expand forcing the piston downward.
   f. Some of the heat energy is converted into motion or mechanical energy.
   g. *Is all of the heat energy converted to mechanical energy?* (No, some of the heat is used to heat up the engine)
   h. *What eventually happens to this heat?* (It is "lost" to the atmosphere) Energy is never lost, but it is lost as far as this system is concerned. This energy is no longer capable of doing useful work.
   i. *What comes out of the exhaust pipe?* (various gases including unburned fuel)
   j. *Do these exhaust fumes have energy?* (yes)
   k. *Can these fumes do any useful work as far as the engine is concerned?* (no)

l. In other words, all of the energy in the gasoline is not used to produce mechanical energy. In fact about 75% of the energy is wasted.
m. We can say then that an internal combustion engine is about 25% efficient.
n. Retrace the flow of energy in this system:

Chemical energy → Heat → Mechanical energy
↓ Heat wasted

2. Demonstrate an electric engine or a model of an electric engine.
   a. Start with the engine dismantled. Point out the different parts.
      magnets
      armature
      brushes
   b. Illustrate the principle
      as a motor
      as a generator
   c. Ask *What kind of energy does this engine use?*
      (electricity)
   d. *Is the electric energy converted to some other form?*
      (Electric energy is converted to mechanical energy)
   e. *Is all of the electrical energy received by the motor converted to mechanical energy?*
      (no)
   f. *What happens to the energy that is not converted to mechanical energy?*
      ("lost" as heat)
   g. *Does an electric motor get as hot as an internal combustion engine?*
      (no)
   h. *Does an electric motor lose energy through exhaust?*
      (no)
   i. In other words, the electric motor does not lose as much heat as an internal combustion engine.
   j. We can say then that an electric motor is more efficient than an internal combustion engine. A large electric motor has an efficiency of 92%. Compare this to the efficiency of an internal combustion engine.

3. Use overhead transparency to discuss the efficiency of other energy converters.
   a. Point out that all energy converters are less than 100% efficient.
   b. Contrast common converters
      Suggestions:
      Fluorecent lamps - Incandescent lamps
      Diesel engine - Steam locomotive
      Home gas furnace - Home oil furnace

EVALUATIVE ACTIVITY: Quiz - See ditto

SUGGESTED EXTRA ACTIVITIES:

1. Compare the efficiency of the Wankel Engine to the efficiency of the standard internal combustion engine.

2. A student could sketch and describe an incandescent lamp and compare it to a fluorescent lamp.

3. Beat a bowl of water with an egg beater. Measure the temperature of the water before and after.

QUIZ

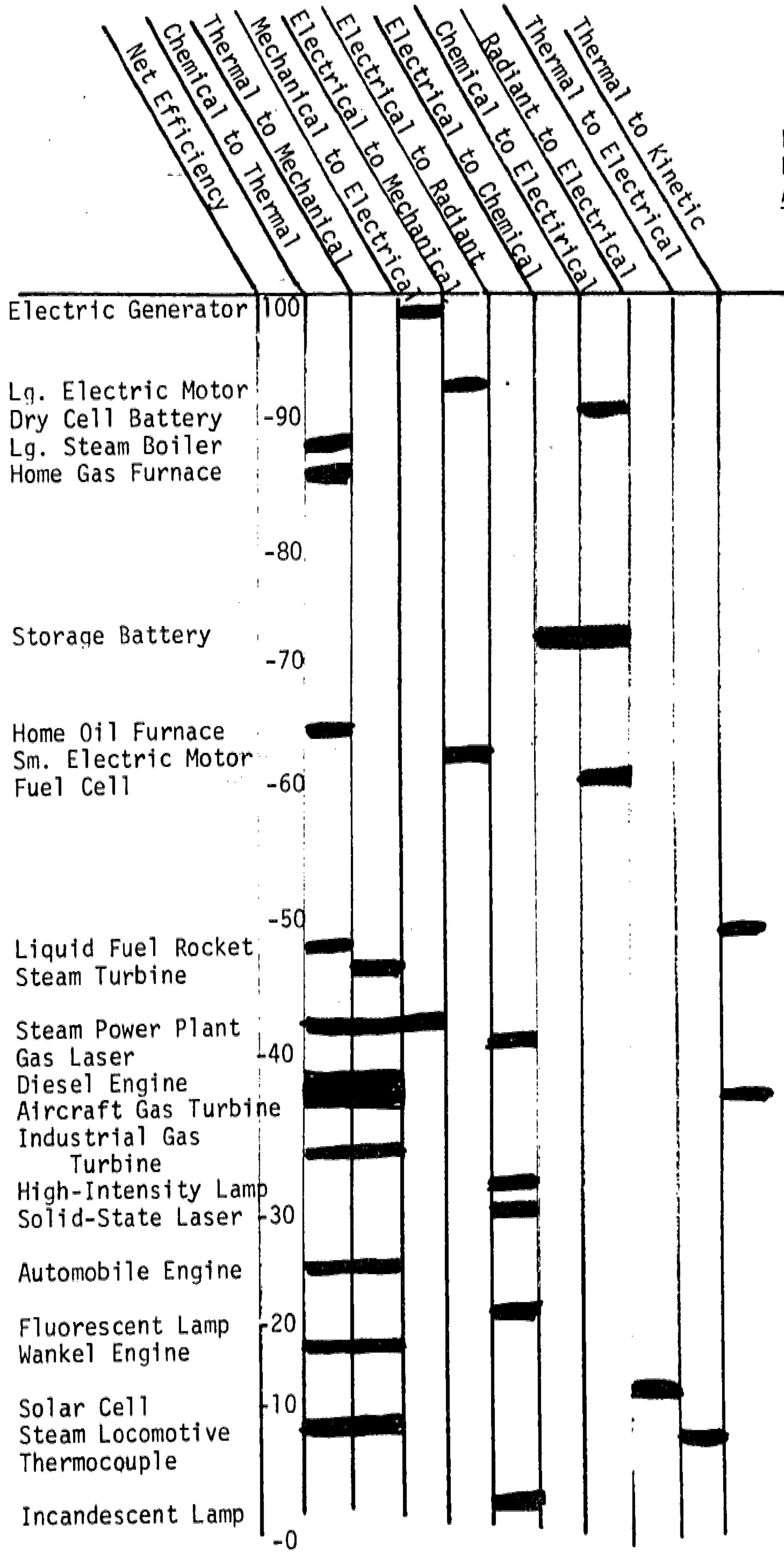
1. Trace the energy flow through an internal combustion engine.

2. What energy conversions take place in the operation of a bicycle?

3. Trace the energy flow from the source of the electrical energy to the motor. Describe all conversions.

EFFICIENCY OF ENERGY CONVERTERS

FROM: "Energy and Power" by Scientific American, Page 97



LESSON 8

CONCEPT: Energy conversion in electricity generation

MATERIALS: Transparency - Flow diagram of Centralia Steam Electric Power Plant
Transparency - Cross section of Ross Dam

PROCEDURE: This lesson is designed to contrast two kinds of electric power plants, the fuel fired steam plant and the hydro-power plant.

1. Begin with a discussion of the importance of electricity to our lifesytle.
   a. Ask the students to calculate the amount of electricity that their household has used. (Refer to lesson 3)
   b. Compare several, figure out an average use for the class.
   c. Have students compare their usage with the average.
   d. Calculate the school's energy use for the same period of time.
   e. Compare school's use and home use.
   f. Ask: *Did you use more electricity on some days than on others?*
   g. *Does school use fluctuate?*

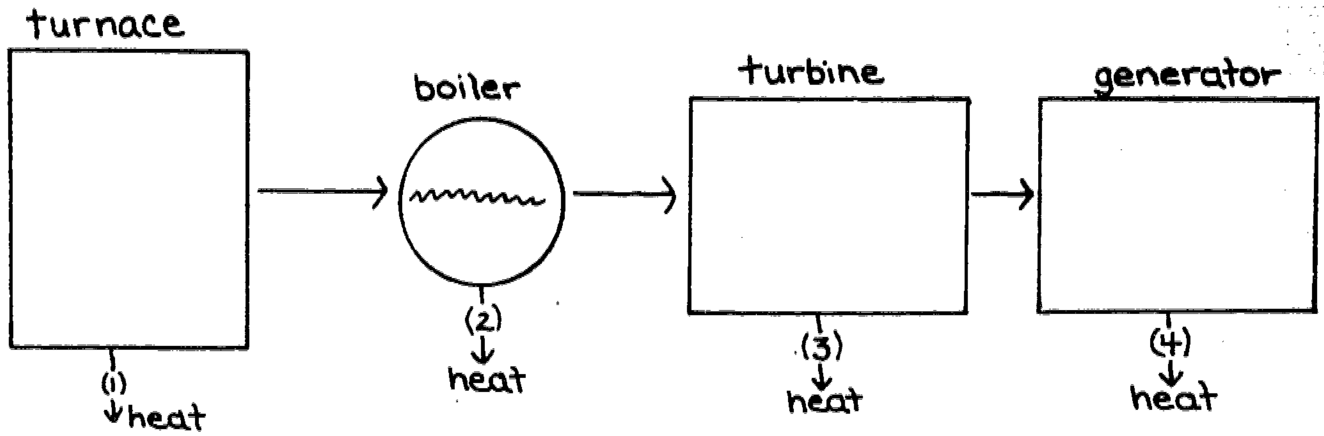
2. Ask: *How would your home life be different if your electricity supply would be cut in half?*
   a. *How would your home life be different if the supply was completely eliminated by a natural catastrophe?* (earthquake, etc.)
   b. *Could the school function without electricity?*

3. Channel the discussion towards the sources of electricity. *Where does our electricity come from?*

4. Discuss the transparency of the new Centralia Steam Electric Power Plant. (See brochure "Centralia Steam-Electric Project")
   a. Point out the general process.
      1) Coal burned
      2) Steam produced
      3) Steam drives turbine
      4) Turbine turns generator
      5) Steam is condensed, cooled and recycled
      6) Stack gases are cleaned and then exhausted

   b. Trace energy flow through the process, emphasizing the conversion of one form of energy to another. Point out that each time the energy is converted, some is "lost" as heat.
      1) Fuel (Coal) to heat
      2) Heat to steam
      3) Steam to turbine (mechanical energy)
      4) Turbine (mechanical) to generator (electricity)

   c. Draw an energy flow diagram of a steam power plant as follows:



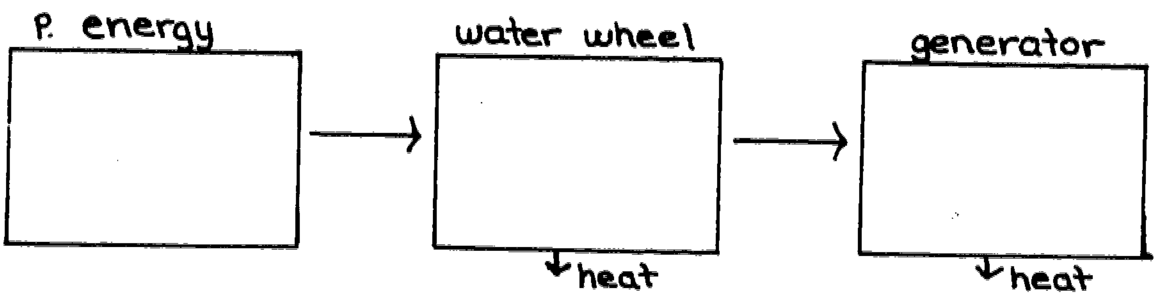
d. Point out that the general process of a steam electric power plant is the same regardless of the kind of fuel used. (oil, natural gas, nuclear).

e. Ask *What happens to all of the heat that is "lost"?* (It is wasted, no longer capable of doing useful work as far as this system is concerned).

f. *How efficient is this system?* (The average efficiency of this type of power plant is about 33%. Therefore 67% of the fuel's energy is wasted.)

5. Discuss a typical Hydropower plant. Use transparency of Ross Dam complex.
   a. Point out the general process
      1) Water is stored in a reservoir behind a dam.
      2) The water has potential gravitational energy.
      3) The water is forced through the penstock pipe under pressure exerted by the water above the penstock.
      4) Water turns a water wheel or turbine.
      5) Water wheel turns generator

   b. Trace energy flow



   c. Ask *Which process is the most complex?*
      (steam power plant)
   d. *Is there more opportunity for energy waste in a steam plant or a hydro plant?*
      (steam)
   e. We can say then that a hydro plant is more efficient. A hydro plant has an efficiency of about 96%. About 4% of the energy is wasted.

6. Point out advantages and disadvantages of both types of power plants
   a. Steam
      Advantages: Can be located anywhere
                  Requires a small site
      Disadvantages: Inefficient
                     Requires non-renewable fuel
                     Causes air pollution, etc.

   b. Hydro
      Advantages: Non polluting (air)
                  Efficient
                  Does not use non-renewable fuels
      Disadvantages: Must be located on river
                     Few acceptable locations left
                     Interferes with fish and wildlife
                     Reservoirs cover valuable land.

EVALUATIVE ACTIVITY: Oral discussion

a. Compare steam and hydro power plants.
b. Ask: *From which type of plant do we get most of our electric power?*
c. Ask: *Why can't we build more dams?*

SUGGESTED EXTRA ACTIVITIES:

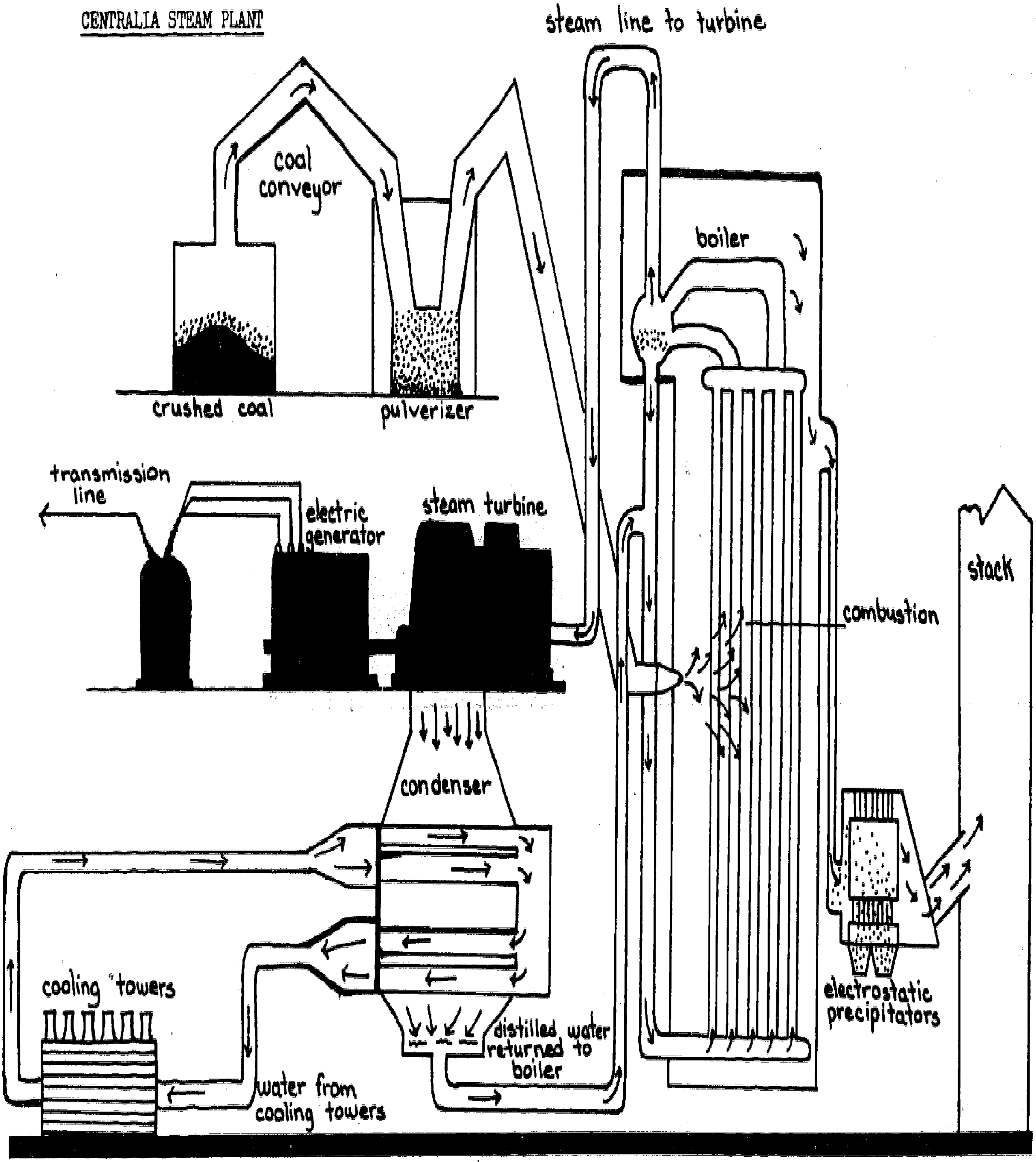
1. Students could make a detailed study of nuclear energy and the use of nuclear energy to produce electricity.

2. Show film "Freedom and Power"

3. Show film "How to Produce Electric Current with Magnets"

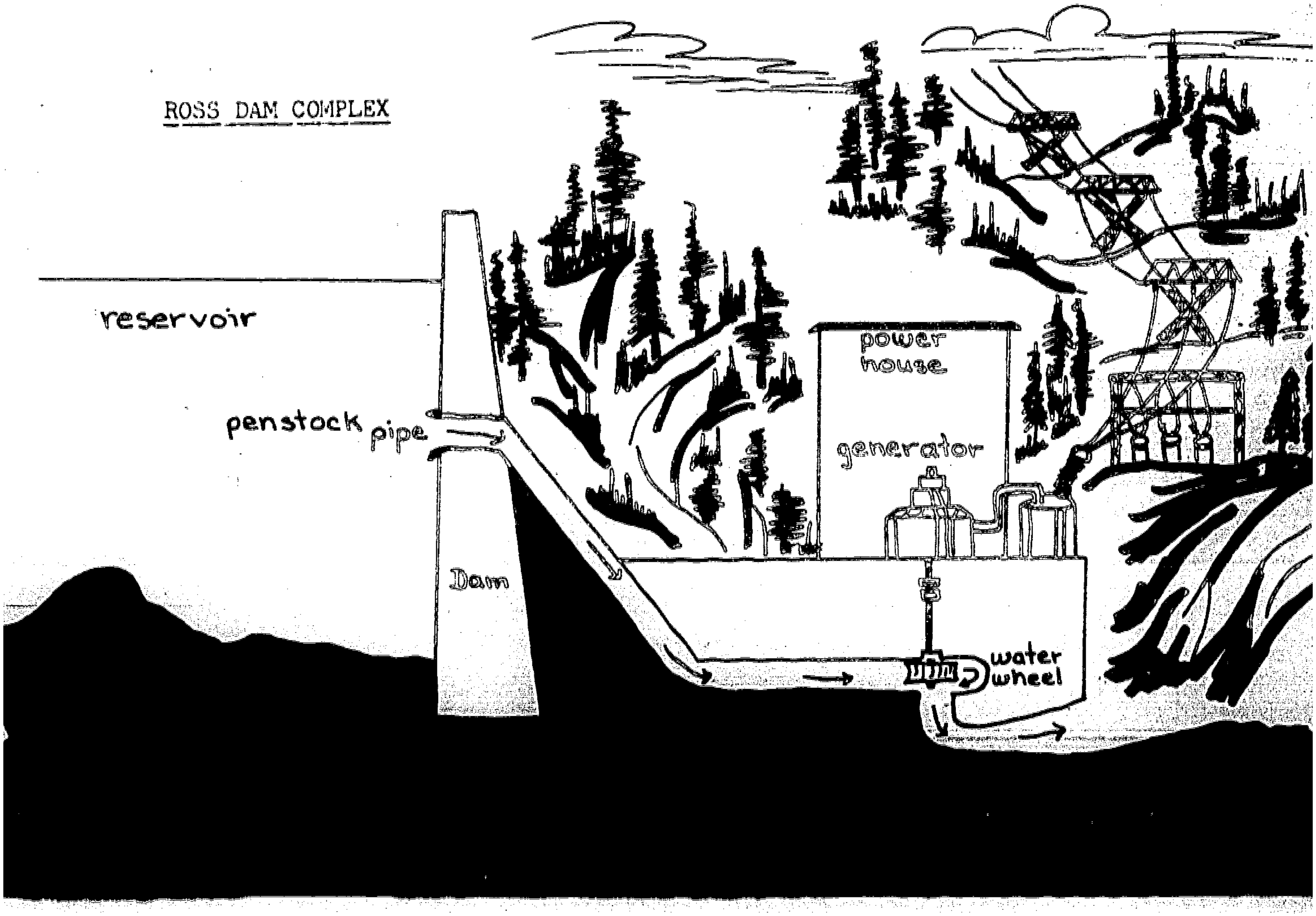
4. Show film "What is Electric Current"

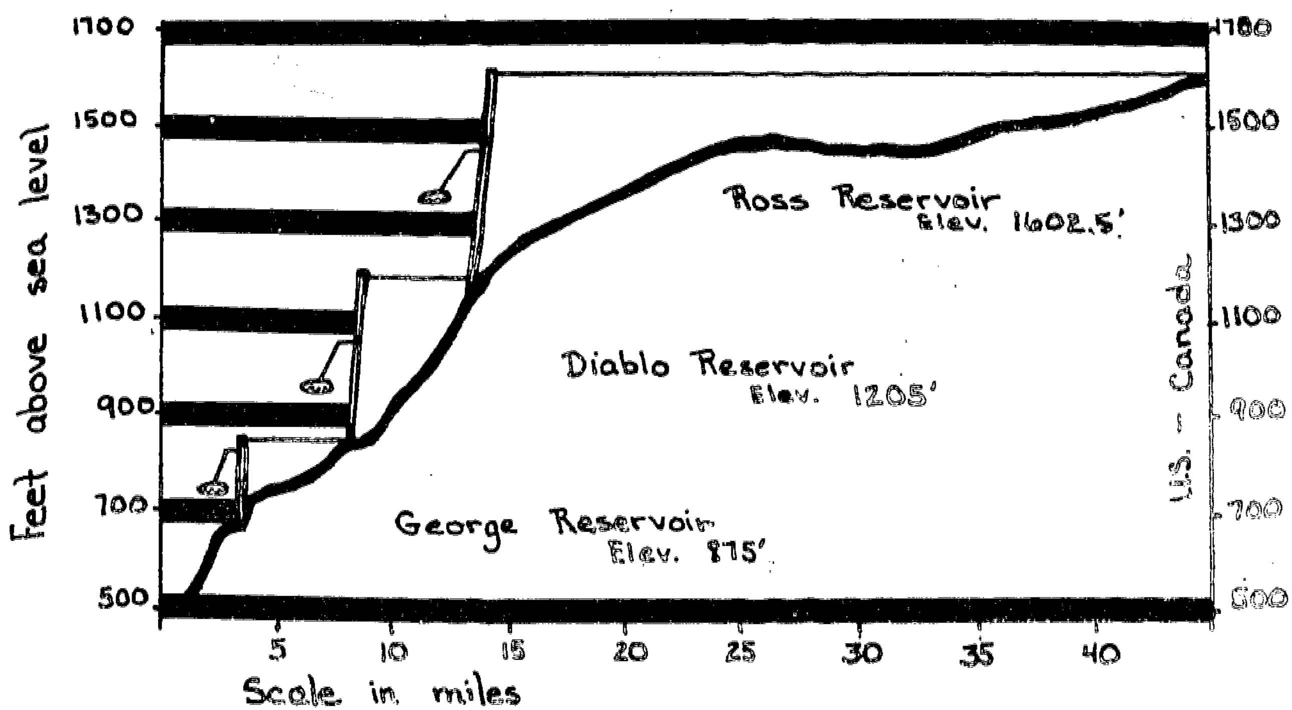
CENTRALIA STEAM PLANT



FROM: Brochure prepared by Centralia Generating Plant

ROSS DAM COMPLEX





FROM: Brochure prepared by Seattle City Light.

LESSON 9

CONCEPT: The need for additional electric energy

MATERIALS: Packet of material - "Hi Ross Dam" from Seattly City Light (may need permission for use.)
Packet of material - North Cascades Conservation eouncil (may need permission for use.)

PROCEDURE:

1. Present the problem:
   a. The population of Puget Sound has increased.
   b. The people of Puget Sound are using more electricity.
   c. Industry is requiring more electric power.
   d. Our generating facilities are almost at capacity.
   e. What are some possible solutions to the problem.

2. Possible solutions:
   a. Raise Ross Dam which would increase water storage which would in turn increase generating capacity.
   b. Construct alternative generating facilities or reduce the use of electricity.

3. Decisions:
   a. Divide the class into two groups, one pro Hi-Ross Dam and one con Hi-Ross Dam.
   b. Pass out packets of materials to appropriate groups with the following instructions:
      1) Prepare a presentation for the class to convince the class that your side is right.
      2) Presentation should include the following:
         a. advantages
         b. disadvantages
         c. alternatives to Hi Ross
         d. Advantages and disadvantages of alternatives
      3) Arrange a method to present materials to class involving as many students as possible.
   c. The students should prepare rebuttal statements.

4. The teacher can serve as moderator. Allow students about 30 minutes to prepare, 15 minutes for each group to present. The rebuttals can be presented the next class period. The students will need help in interpreting the material. The teacher should try to spend an equal amount of time with each group.

EVALUATIVE ACTIVITY: Have students imagine that they are voting on the above issue. Write a brief statement supporting his or her vote.

SUGGESTED
EXTRA
ACTIVITIES:

1. Four groups of people are going to set up housekeeping adjacent to each other along a river. They will generate their own electricity: Group 1 using coal; group 2 using natural gas; group 3 using nuclear power; and group 4 using hydro-power. Have each group defend its plant. Each group can oppose the plans of the other groups. Have a debate to solve the problem, choosing the best method of providing electric power.

2. Have a guest speaker from each side.

LESSON 10

CONCEPT: Conservation of energy

MATERIALS: Student Energy User Inventories

PROCEDURE: The student should have a basic understanding of the shortage of energy and that in the future he or she might have to make decisions in order to conserve energy.

1. Begin the discussion by focusing on the future.
   a. Ask the students *How old are you?*
      (12 or 13)
   b. Ask *How old will you be in 1995?*
      (34 - 35)
   c. State *That is the year that scientists have predicted that we will run out of petroleum products (oil, gasoline, etc.) if we continue to use these products at the present rate.*
   d. *What will you do for transportation? Fot heat? For plactic products?*
   e. *How will your lifestyle change?*

2. Continue discussion with other forms of energy.
   a. Natural gas - reserves of 10.2 years.
   b. Coal - reserves of 200 years.
   c. Nuclear fuel - reserves of 20-30 years.

3. Ask *How could we prolong the eventual elimination of these energy sources?*
   (to reduce our rate of use)

4. Ask students to review their electric energy users inventory.
   a. Suppose that the government passed a law requiring all people to cut their electric consumption in half.
   b. Arrange your electric appliances in order of priority. Make a list with the most essential appliances on top.
   c. Divide the total usage by two. The answer will be the amount of electricity you have available.
   d. Eliminate appliances from your list until you are down to the required amount.
   e. Compare the lists of students. Ask them to defend their list of essential appliances?

5. Have students review their fossil fuel users inventory.
   a. Assume that gasoline and oil are rationed and that the price of gasoline is $1.00 a gallon.
   b. Discuss what changes must take place to conserve gasoline and to save money.
      1) eliminate non-essential fossil fuel users
      2) sell the large car and buy a small car
      3) use mass transit
      4) ride bicycles
      5) walk
      6) turn down heater thermostat and heat only necessary space

EVALUATIVE ACTIVITY:

1. Oral discussion - design living quarters of the future keeping in mind the shortage of energy.

2. Oral discussion - design transportation system that would conserve energy.

SUGGESTED EXTRA ACTIVITIES:

1. Calculate the amount of energy required to manufacture small convenience appliances. Suggestions: electric tooth brush, hot comb, electric mixer, blender.

2. Calculate the amount of energy required to operate a large car and a small car for ten years. Compare.

LESSON 11

CONCEPT: Energy sources in the future

MATERIAL: Solar Cell Demonstration Kit
Overhead Transparencies
1. Wind as a Power Source
2. Solar Collector

PROCEDURE:

1. (Put list on chalk board)
   Assume that a perfect energy source would -
   a. be unlimited in supply
   b. be equally distributed throughout the world
   c. present no technological problems
   d. be highly efficient
   e. present no aesthetic problems
   f. have no adverse impact on the environment.

2. The student will select the energy source that he feels will best meet the above criteria.

3. Have students defend their choices.

4. Discuss wind as a source (use overhead transparency)
   a. Possibilities
      1) as a generator of electricity
      2) to use that electricity in electrolysis of water.
   b. Advantages - all of the above.
   c. Disadvantages
      1) the wind does not blow continuously
      2) In order to provide continuous power, an expensive network would have to be constructed.

5. Demonstrate Solar Cell (use kit and overhead transparency)
   a. Sun light converted directly to electricity
   b. Advantages - all of the above
   c. Disadvantages
      1) What about night time?
      2) What about cloudy days?
      3) Very expensive ($4.00/sq. inch)
      4) Requires 15,000 acres of area for enough power for Seattle

6. As a wrap up and review for this unit, show the film "The Energy Crisis." (12 minutes)
   a. Make the following points
      1) We are an affluent society requiring more and more energy.
      2) We are more and more dependent on energy sources that are being depleted. (oil, gas, etc.)

3) In order to maintain our present life style, we must search for energy sources that are long lasting and not detrimental to our environment.
4) We must commit ourselves to conservation of energy.

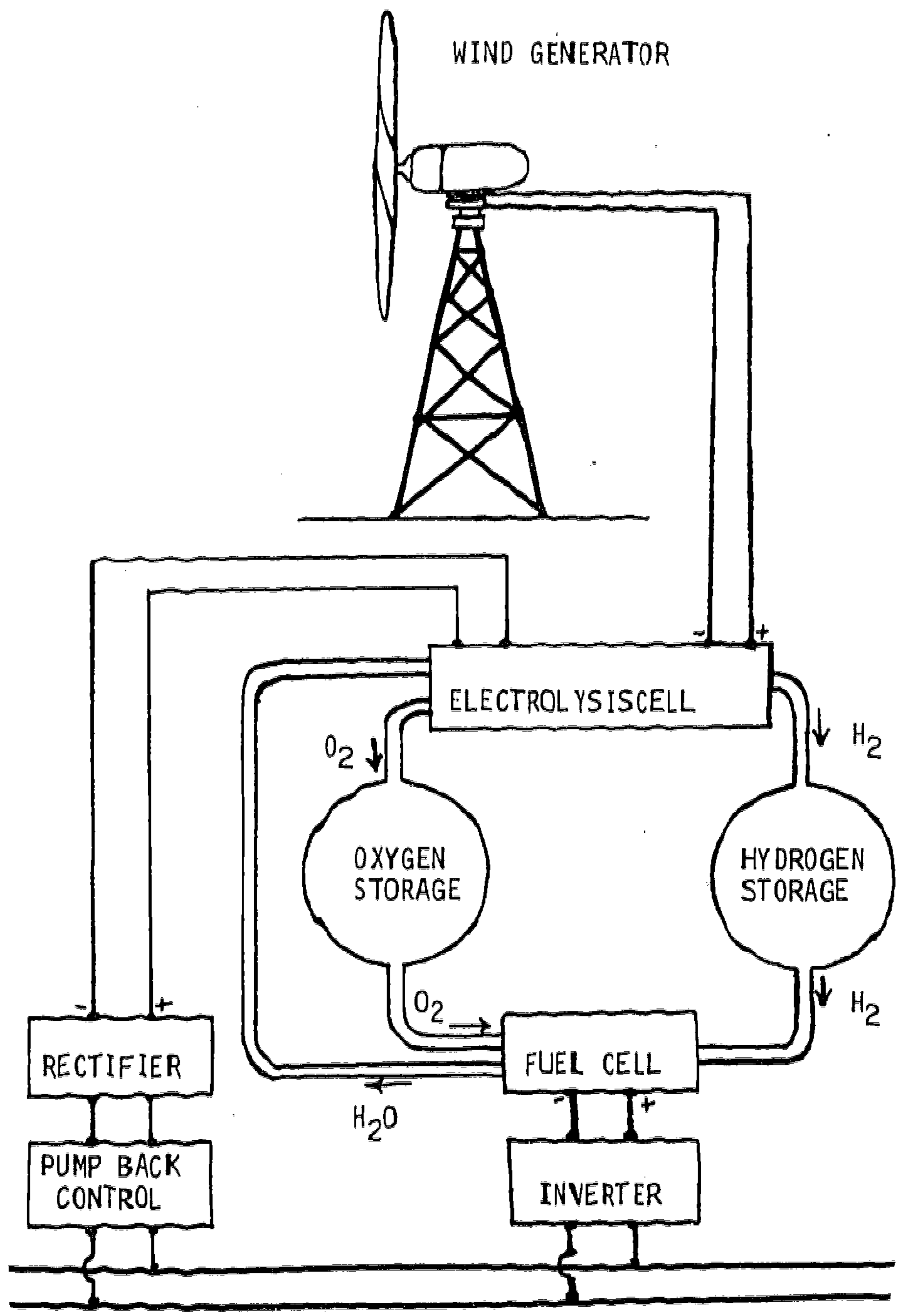
EVALUATIVE ACTIVITY: A brief oral discussion of the film, emphasizing the above points should indicate the students' understanding of the energy crisis.

SUGGESTED EXTRA ACTIVITIES: The student could prepare a report on various energy sources being researched.

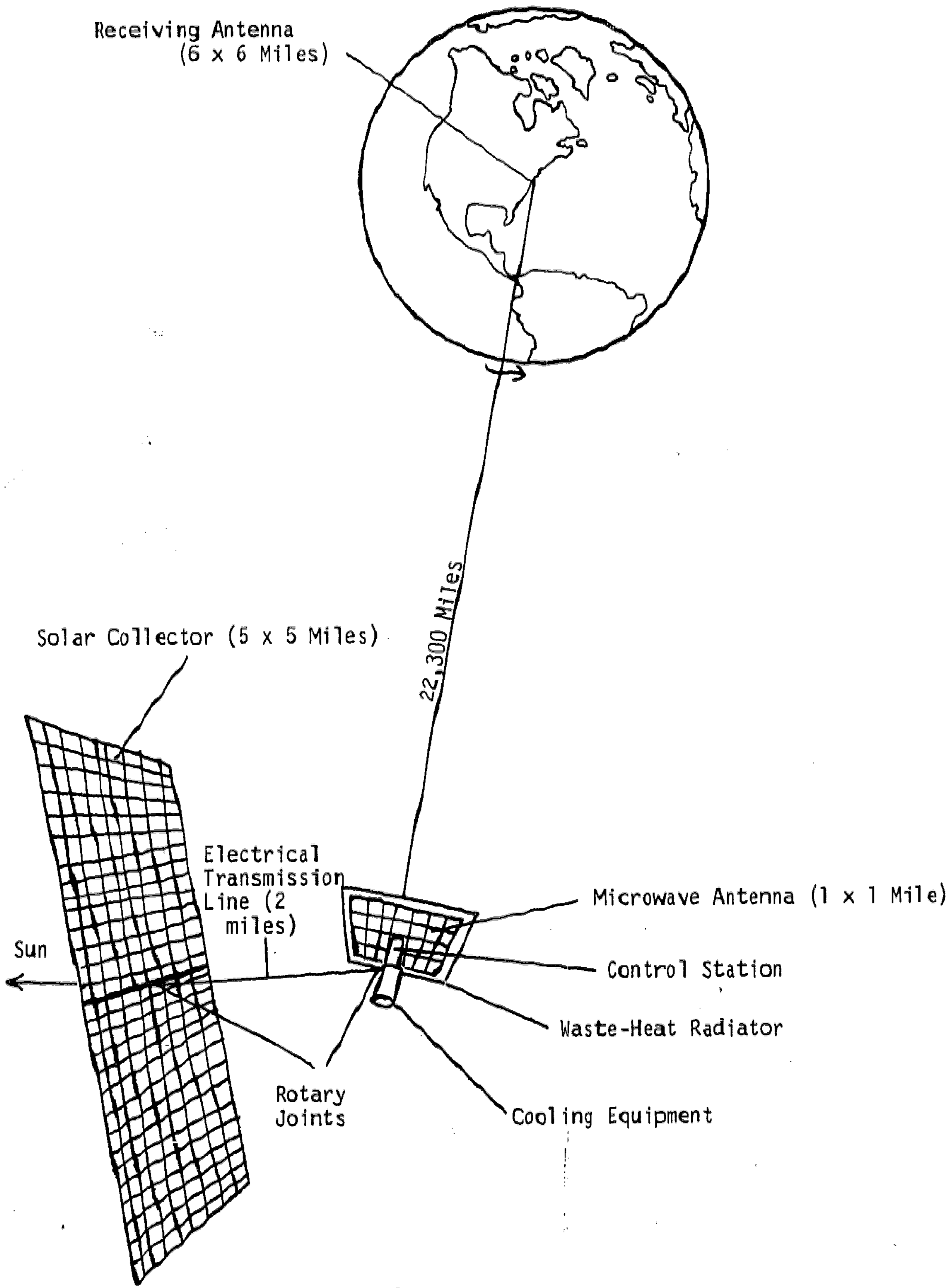
Suggestions:

Nuclear reactor, Breeder reactor, Solar energy for home heating and cooking.

WIND AS A POWER SOURCE



SOLAR COLLECTOR



For your convenience the films used in this ELE are listed on this tear out sheet. Simply add the dates required and mail to the Instructional Material Center, ERAC.

Project ECOLogy

Detach here

INSTRUCTIONAL MATERIALS - HIGHLINE PUBLIC SCHOOLS

Symbols for materials not booked:
NA - not available
Sub - substitution
WD - withdrawn

ORIGINAL

Please try to place orders
3 weeks in ADVANCE in DUPLICATE

SCHOOL ______ TEACHER ______ GRADE ______ DATE ______

FILMSTRIP NO.	FILMSTRIPS - TITLE	DATE WANTED	NOT WANTED AFTER	DATE CONFIRMED	FILMS	DATE WANTED	NOT WANTED AFTER	DATE CONFIRMED
	Story of Oil				Energy and Work			
	Natural Gas				Energy Crisis			
					Freedom and Power			
					How to Produce Electric Currents with Magnets			
					What is Electric Current			